

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC. 20554

In the Matter of

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Inquiry Regarding Carrier Current)
Systems, including Broadband over) ET Docket No. 03-104
Power Line Systems)

To: The Commission

Reply Comments to Notice of Inquiry (03-104)

**Reply Comments by the Amateur Radio Research and
Development Corporation (AMRAD)**

INTRODUCTION

AMRAD is a non-profit scientific and educational corporation dedicated to the development and furtherance of electronic and communication technologies. Our members are licensed amateur radio operators and many members are degreed electrical engineers with extensive professional experience in the fields of communications and computers. AMRAD has developed a number of new communications techniques over the years and AMRAD work is presented in national and international publications, books and forums.

As active computer users, AMRAD understands the need for high speed Internet connections to the home. The spotty availability of this capability is experienced by our members and the need for new means for these connections is a matter of much discussion. The addition of the power companies as another source of high speed Internet connections is seen as desirable and useful.

In response to FCC interest in the technology, AMRAD took the initiative to put together a test van and a test bed to learn more about the technologies that may be used to build Broadband over Power Line (BPL) systems. AMRAD members performed a limited amount of laboratory testing as well as making field trips to BPL test sites and to radio amateurs homes to conduct field testing and observations. This work is only a very small amount of what needs to be done before the full extent of the impact of BPL can be observed and measured. AMRAD encourages others to duplicate our work to see if it can be duplicated in different labs, with different equipment and at different sites. We welcome inquiries and will share the details of our test bed and setups down to the construction

detail of our wideband transformers.¹ In particular we agree with the National Telecommunications and Information Administration program which is launching a modeling, analysis and measurement effort. We see this as an example of the important and necessary testing effort required before the full extent of the impact of BPL can be observed, measured and assessed.

In general, we welcome multiple competitors in the Internet delivery business. We see all of our utility companies, which own infrastructures throughout our neighborhoods, as viable deliverers of Internet to the home. We concur with the Verizon comments² which ask that all broadband providers be treated equally. It is striking that Verizon, as a major wireline company states that "Local wireline companies are subject to a host of crippling regulations that do not apply to their competitors."

AMRAD'S WORK

The FCC NOI inquired whether the existing Part 15 rules were adequate to protect authorized users of the spectrum.

AMRAD is of the opinion that the existing Part 15 rules are an adequate, proven, predictable and stable set of interference mitigation rules for all radio spectrum users. Departure from the current baseline of these rules invites troublesome unintended consequences that will be hard to correct.

On the other hand, our observation is that broadband signals which conform to the Part 15 level requirements are well above the ambient noise and will interfere with many forms of reception. The exact impact of these signals on amateur radio is unclear in our testing because the Homeplug standard which we tested features a notching of the amateur radio bands. Other systems, while conforming to Part 15 levels, could cause more serious interference problems. One reason is that Part 15 was written when narrowband carrier type signals were being regulated. Using these same levels for the broadband signals as in BPL designs, denies the narrowband user the option to change frequency to sidestep the interference as it is everywhere within a frequency band.

INTERFERENCE

Paragraph 15.5 and 15.15 directs that radiators "shall not be deemed to have any vested or recognizable right to continued use" and provides for cessation of operations when harmful interference occurs. We understand these rules will require power companies or their subcontractors as operator of unlicensed Part 15 systems to make provision for accepting and responding to requests for selective shutdown as required to mitigate harmful interference. We envision each BPL operator having a 24/7 operations center to work in real-time to resolve interference complaints by cessation of operations in localized areas if required to resolve interference problems.

INTERFERENCE TESTING

AMRAD equipped a van to monitor interference throughout the HF band. We visited the

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² Comments of Verizon on ET Docket No. 03-104

Potomac Electric Power Company test site at Potomac MD to make observations. We observed RF pulses well above the ambient noise. It was prominent above other neighborhood unintentional emissions and would interfere with International Shortwave broadcasting. The observed pulses were clearly related to data packets and with more data packets, as the system becomes more loaded, there would seem to be more pulses and interference. During periods of low data activity, the RF pulse density became very low and caused little interference. Of course, as subscribers are added, these periods of low activity would become infrequent.

During periods of moderate data activity the pulses were much higher outside the radio amateur bands while maintaining a lower level within the radio amateur bands with the exception of the 60 meter band. This spectral signature is consistent with the Homeplug standard. The pulses were heard with similar signal strengths all along the lines in the neighborhood indicating that the signal does not act as a point source. Our observations of BPL emanations is consistent with prior experience with other powerline noise where the source is very diffuse and difficult to locate because does not exhibit point source characteristics. Further testing is imperative.

We concur with Current Technology's perspective³ in their comment that BPL systems "... need to prevent *added* real-world harmful interference to licensed services." and that⁴ "... on-site measurements remain the gold standard." This perspective is the very basis of our concerns based on our direct observations from the street of the BPL deployment in Potomac, MD, where BPL's characteristic pulses significantly raised the background emanations whenever Internet subscribers are active and transferring data.

Thus, AMRAD feels that Part 15 statements protecting licensed radio services against interference from Part 15 devices adequately protect the radio amateur community.

SUSCEPTIBILITY

Part 15.17 provides for the designers to "consider the proximity and high power of non-Government licensed radio stations such as broadcast, amateur, ... during the design of their equipment so as to reduce the susceptibility for receiving harmful interference."

Over the past month AMRAD has conducted susceptibility testing in both the laboratory and in the field on a device using the Homeplug standard. In the laboratory our observations are that the system is vulnerable and will collapse with no data transfer when RF fields induce one volt or more of RF into the power line. The system is sensitive to interference over the range of 4 to 21 Mhz and does not exhibit less vulnerability in the radio amateur bands. At lower levels of interference, the system signaling appeared to be doing adaptations to work around the interference.

AMRAD sought to conduct field testing as the gold standard of our BPL testing. Our testing was limited to a single site on one day. Our field testing demonstrated in one home that an amateur radio station on the 20 meter band induced a loss of 87% of the data

³ Current Technologies Comments on ET Docket No. 03-104, Page 12

⁴ Current Technologies Comments on ET Docket No. 03-104, Page 19

packets in a system using the Homeplug standard at a transmitter power of 10 watts. This was with an outdoor antenna 40 feet high and 40 feet from a residential house where a Homeplug local network was operating between two levels of the house. At 100 watts under the same conditions, a 100% packet loss occurred.

The test configuration is quite representative of an amateur station operating in a suburban environment using Romex wiring. The RF at the power receptacle used for the data transmission testing was measured line-to-neutral using an RF broadband transformer, a 1.8 MHz high pass filter and an RF millivoltmeter. Details of the RF levels measured^{5 6 7 8 9 10} indicate that radiated interference from the antenna induced RF energy into the power wiring of the house and caused the observed conducted interference to the test local area network.

This single set of tests, if reliably repeated in further testing in other houses and other neighborhoods and with the same system, suggests a radio amateur using legal power of 1500 watts near a Homeplug based BPL system would induce data failure at distances beyond 40 feet from the antenna and would interfere with multiple neighbors. Under Part 15, paragraph 15.5 interference of this type to a BPL and/or Homeplug system “must be accepted that may be caused by the operation of an authorized radio station...”. Designing improvements in the BPL systems to mitigate this interference could harden the system to the problems we observed and to interference from other licensed users of the spectrum.

ENFORCEMENT

We are concerned whether FCC will be able to enforce Part 15 rules as written if a portion of a neighborhood's Internet service is interrupted for extended durations by a single radio amateur or other FCC licensed radio transmitter of relatively low power operating in a legal manner with a technically correct system. How will the FCC proceed in such situations under Part 15 rules while maintaining the FCC's historical commitment to protection of licensed services?

We are concerned that the necessary FCC efforts to mediate BPL interference incidents would be numerous and frequent, overburdening staff.

The FCC is facing some serious decisions on whether to continue with past rules and historical enforcement or to dispense with their historical role and substitute rules which give the unlicensed Part 15 system priority over the licensed systems such as the amateur radio

⁵ When the Homeplug device and transmitter were off, the quiescent RF voltage was 0.15 mv

⁶ With the Homeplug device sending packets of data the RF voltage was 0.55 volts.

⁷ With the Homeplug device disconnected, and the transmitter on 20 meters at 10 watts connected to the antenna, the RF voltage at the receptacle was 55 mv.

⁸ With the Homeplug device disconnected, and the transmitter on 20 meters at 100 watts connected to the antenna, the RF voltage at the receptacle was 200 mv.

⁹ With the Homeplug device disconnected, and the transmitter on 20 meters at 10 watts connected to the dummy load, the RF voltage at the receptacle was 0.2 mv.

¹⁰ With the Homeplug device disconnected, and the transmitter on 20 meters at 100 watts connected to the dummy load, the RF voltage at the receptacle was 0.5 mv.

service. Such changes to Part 15 rules would tip the responsibility of compliance so as to favor the unlicensed users and leave the FCC facing a large number of harmful interference complaints to resolve.

CONCLUSION

The FCC is facing a serious decision on BPL. We have seen suggestions for a BPL system based on 802.11 for its delivery from the power pole to the home and fiber from the central office to the power pole. This technology achieves the desired result without generating wideband RF signals and creating the risks of interference. The growth of 802.11 is bringing this technology quickly down the learning curve and costs are expected to continue falling. We now see notebook computers in the market place with an embedded 802.11 wireless capability built into the CPU as part of the base design.

On the other hand, we have seen BPL test systems here in the suburban Washington D.C. Area which appear to be elaborate and expensive to install.

NTIA indicates they are conducting measurements and suggests that a measurement effort be coordinated at an appropriate technical working level¹¹. The FCC should proceed slowly and with caution and participate in coordinated testing with the NTIA and others to explore and understand the full impact of these proposed technologies. Testing for BPL system susceptibility appears to be an important issue that has so far received little attention.

Changing Part 15 at this juncture could unleash a torrent of complaints and problems that will be expensive and troublesome to correct. The better course is to proceed when full knowledge is in hand and the unintended consequences of FCC actions are reduced to a minimum.

There are numerous technology options available to bring the Internet from the street to the home such as wireless technology and fiber to the home technology. Our very limited testing suggests that the BPL technology could prove to be unreliable, troublesome, risky and expensive. Meanwhile, during the period in which the BPL technology is perfected other fast maturing technologies might be able to serve the need better and cheaper.

In the effort to provide the needed broadband connection to the home, the superior technology for power companies to use may prove to be something other than these technologies which send RF signals down the power lines.

The FCC must take a mid-term look at the issue and assess whether these proposed BPL technologies will be overtaken by other technologies such as 802.11 or fiber to the home.

The FCC must assess whether BPL will prove an unreliable, marginal system with expensive remedial and mitigation actions while other technologies become the mainstream technology.

¹¹ NTIA Letter to Mr. Thomas, FCC dated July 1, 2003

The FCC must assess how it will direct the BPL operators to cease operation in a neighborhood if required to mitigate interference.

The FCC must assess how they will continue with Part 15 to support the licensed users when the BPL systems are interfered with.

The FCC must assess the public good of the neighborhood and utility company business interests against the rights of one legal user of a radio receiver or transmitter.

With present uncertainties, only completion of testing suggested by us and others can give the results needed to make this assessment.

If regulatory barriers are forcing the decision rather than technological barriers, then the FCC should examine how the better technology can be enabled with regulatory changes. The FCC efforts should remain focused on providing broadband to the home and not focus on any specific technology.

In the end, the FCC must proceed with great care and take actions now to conduct testing to gather critical information. More information is needed to make regulatory assessments leading to decisions later that will prove correct over time and will provide expanded distribution of broadband to the home.

Respectfully Submitted,
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